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EFFECT OF CABIN CRUISER WASTE DISCHARGE ON A SMALL HARBOR

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EFFECT OF CABIN CRUISER WASTE DISCHARGE ON A SMALL HARBOR

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and
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SYNOPSIS

A survey was made during the 1953 yachting season to determine the effect of cabin cruiser waste discharge on a sheltered harbor. The observed effects of tidal movement, boat concentration and activity, and character of direct discharges are indicated. The efforts of state and municipal agencies to control harbor pollution resulting from small craft waste discharge are reviewed. Public health aspects, and implications concerning the safety of such harbor waters for use in shellfish culture and bathing are discussed.

INTRODUCTION

Sheltered harbors suitable for overnight anchorage of boats of cabin cruiser size abound along the Atlantic Coast from Maine to Florida, along the Gulf Coast, and at many locations along the Pacific Coast. The Great Lakes and the Ohio, Mississippi and the Missouri Rivers with the tributaries also have such craft used for pleasure in summer months. Numerous inland lakes, such as Lake Tahoe, on the California-Nevada border and others of lesser size are used each summer by recreation-minded families.

Persons aboard these small craft normally discharge body waste, galley waste, and other debris into or upon the water on which the craft may be when in use. Such activity taking place while boats are at anchor for some period of hours or overnight constitutes a waste disposal practice that may be challenged on the grounds of potential sanitary hazard. Specifically: does pollution from small craft, such as cabin cruisers, affect the waters of sheltered harbors and the use of those waters for such purposes as bathing, shellfish culture, or related water use?

In 1953 the Interstate Sanitation Commission sought to resolve the question by study and research. New York University College of Engineering cooperating with the Commission and the New York State Department of Conservation conducted the study of a small harbor on Long Island.

The Study

Requirements for the harbor to be studied in this survey were:

1. That it be relatively free of external sources of pollution.

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2. That it be reasonably well confined so that samples could be taken from a small boat at selected sampling locations within a reasonable time period.
3. That it be used by cabin cruisers consistently and in some concentration throughout the summer season.
4. That it be a location where boats would be at anchor with persons aboard for some period of hours.

The Harbor is a small spit protected body of water. The only habitation at the Harbor is a United States Coast Guard Station. The surrounding land is in estates. One small tidal arm enters the harbor opposite open water of Huntington Bay and the Sound. Coast Guard boats are anchored at docks at the closed end of the harbor. All sewage of the Coast Guard Station is treated in septic tanks and effluent is discharged into sands of beach area on the Sound. There was no observable direct discharge of sewage from any source other than boats.

The harbor is within easy cruising distance of many yacht harbors in the New York Metropolitan Area and the Connecticut shore. The distance from the Battery in New York is about 35 miles and from Stamford, Connecticut, about 9 miles.

The tidal range in the harbor is about six feet over a 12-1/2 hour cycle. At periods of low tide, clam beds on the reefs are exposed. The shore line around the spit is sand and gravel and lends itself to recreational usage. Bathing from boats at anchor and from the beach is commonplace.

Two main sampling courses were established for the harbor; one on either side of the harbor center line. Stations 1, 2, 3, and 4 are on Course A. Stations 5, 6, 7, and 8 are on Course B. Stations 1, 2, 5, 6, 7, cross-section the protected area of harbor and cover the area of principle anchorage for small craft. Station 1 should reflect the effect of the Coast Guard Anchorage. Stations 3 and 4 are adjacent to the clam beds and straddle a small tidal swamp. Station 8 is just inside the harbor channel and is representative of water over another clam bed. The harbor is comparatively shallow (maximum depth at low tide USC & GS Datum 21 feet). The surface area of the harbor is estimated at 48 acres. The approximate tidal prism volume is 12,000,000 cubic feet. The approximate basin volume is 225,000,000 gallons.

Samples for bacteriological analyses were taken with an underwater bacteriological sampler at five feet depth. Samples were stored in an iced container until delivered at the laboratory. All samples were analyzed according to Standard Methods of Analyses using a series of 3 tubes each at dilutions of 1.0, 0.1, and 0.01 ml. in Lactose Broth. All positive tubes were confirmed in Brilliant Green Bile transplants incubated 24 hours.

Field data were taken on each run. Runs usually required 10 to 15 minutes to complete. All sampling was done by boat. The more important data recorded for each station included: time of sampling, air temperature, wind direction and velocity, weather, tide, presence of floating solids, and water temperature. Boat census, notable facts about appearance and character of water, use of water, use of shore, and activity aboard boats were noted during each period of survey. During the summer, small craft cruise in on Friday night and Saturday. The craft remain at anchor until some time on Sunday. A few boats are entering and leaving over the period, but the outward movement becomes significant after mid-morning on Sunday. In order to have reasonably stable population of boats, most of the surveys were made on Sunday morning.

A second important point considered was that of boat activity. There are always a few early risers. Therefore, it was considered important to have at least one run of a survey period conducted while there was no boat activity

(i.e. at or near dawn). It was considered equally important to have the survey cover the period of maximum boat activity (i.e. the time of rising, breakfast, and preparation for the day's events). It is probable that the time from dawn to 10 A.M. included the major portion of such activity.

The series of surveys made from May 30, 1953 through September 6, 1953:

1. Spanned various conditions of tidal movement.
2. Encompassed both non-activity and activity aboard boats.
3. Included a fair representation of shore and water use. (Swimming, boating, shellfish gathering, etc.)
4. Cross-sectioned weather conditions (heat, cold, wind, storm, sunlight and cloudiness).
5. Cross-sectioned the random choice of the harbor as a week-end anchorage.

Eleven surveys were made between the hours of dawn and 9 to 10 A.M. on week-ends. Three holidays were included in the study.

The Conservation Department of New York State provided a series of three runs to establish some information about the harbor under conditions of non-use by small pleasure craft. The first was made in early May, the second on July 7, following the holiday and the third in October approximately one month after the cessation of pleasure craft movement.

Survey Results

Conservation Department

Twenty-three samples were collected in 3 runs made May 12, July 7 and October 26, 1953. A maximum MPN/100 ml. of 1100 was found in one sample taken at Station 6 on May 12. The second highest MPN of 240 was found in one sample taken at Station 1 on July 7th. The third highest sample having an MPN/100 ml. of 93 was taken at Station 1 on October 26th. The balance (87%) of the samples indicated that water at other times was well within the bacteriological limits for shellfish water (less than 70 MPN/100 ml.). The mean MPN/100 ml. was 77, the mode was 23 and the median group MPN/100 ml. was 23. All mean values given in this report are calculated by using a value of zero for all counts less than 0.30/ml. The mean value recorded is therefore a minimum or lower limiting value.

Week-end Surveys

A total of 384 samples was collected at 8 sampling stations during 11 survey periods.

A study of these data according to station frequency distribution (Table 1) shows quickly that Stations 3 and 4 are not subject to excessive pollution whereas Station 6 is. The majority of all samples taken at Stations 3 and 4 have an MPN/100 ml. of less than 30 whereas 62% of samples at Station 6 are equal to or greater than 36/100 ml., the median group MPN for the entire basin. 20% of all samples taken had an MPN/100 ml. equal to or greater than 72/100 ml. (i.e. they were above the allowable MPN for approved shellfish waters).[3]

Stations 1, 2, 5, 6, and 7 indicated pollution levels that were border line in that they equalled or exceeded an MPN of 36/100 ml. in 50% of the samples taken.

3. Manual of Recommended Practice for Sanitary Control of the Shellfish Industry. Pub. Health Service Publication #33, 1946.

TABLE 1

CABIN CRUISER POLLUTION SURVEY
Eatons Neck Harbor
1953

MPN Frequency by Station

	Samples																	
	1		2		3		4		5		6		7		8		Total	Basin
MPN	No.	P	No.	P	No.	P	No.	P	No.	P	No.	P	No.	P	No.	P	No.	P
0.30*	23	100	23	100	25	100	32	100	14	100	18	100	20	100	25	100	180	100
0.30	1	52	1	52	2	48	2	33	3	71			3	58	1	48	13	53
0.36	11	50	15	50	18	44	12	29	16	65	8	63	16	52	17	46	113	50
0.72									1	31			1	19			2	20
0.73	2	27	1	19					4	29	2	46	3	17			12	20
0.91	7	23	5	17	3	6	2	4	7	21	6	42	3	10	2	10	35	17
1.10													1	4			1	8
1.50	1	8	1	6							2	29					4	7
2.30	1	6	1	4					2	6	5	25	1	2	2	6	12	6
4.30	1	4									4	15			1	2	6	3
9.30	1	2	1	2					1	2	1	6					4	2
21.00											1	4					1	1
24.00											1	2					1	0
Total	48		48		48		48		48		48		48		48		384	
Mean**	0.61		0.50		0.20		0.14		0.64		2.00		0.35		0.36		0.597	

* Less than the value shown

P Percent of samples equal to or greater than the value shown

** The means in this table and all subsequent mean values are computed on the basis of assuming a zero value for all counts less than 0.30/ml.

TABLE 2

CABIN CRUISER POLLUTION SURVEY
Eatons Neck Harbor
1953

Comparison of Pollution Intensity

For Periods of Boat Activity

Percent of Samples Equal to or Greater than MPN 36/100ml.

Period	Station 1	2	3	4	5	6	7	8	Total
Early morning	55	36	73	36	64	45	45	36	48.9
07:00 to 08:00	27	54	27	18	36	45	27	45	35.2
08:00 to 09:00	55	55	64	27	73	55	45	82	55.7
After 09:00	58	58	17	33	75	100	75	17	54.2
	Percent of Samples Equal to the Maximum MPN								
Early morning	0	0	0	0	0	0	0	9	1.1
07:00 to 08:00	0	0	0	0	0	9	0	0	1.1
08:00 to 09:00	0	0	0	0	0	27	0	9	4.5
After 09:00	0	0	0	0	0	8	0	0	1.0
	Mean MPN/100 ml.**								
Early morning	36	16	31	18	35	26	24	36	28
07:00 to 08:00	20	35	17	9	21	212	10	21	43
08:00 to 09:00	43	44	23	13	57	135	40	83	54
After 09:00	149	105	13	17	128	144	57	6	115

** See Note Table 1

Boat Activity

In order to examine the effect of boat activity the sampling was divided into four time periods.

1. Early morning - first run.
2. 7 to 8 A.M.
3. 8 to 9 A.M.
4. After 9 A.M.

Table 2 summarizes the information found before 7 A.M. and after 9 A.M. respectively with respect to boat activity. 100% of samples taken after 9 A.M. were equal to or greater than 36/100 ml. MPN. Using 50% as a base the greater periods of pollution were found at Station 1 in the early morning and from 7 A.M., at Station 2 from 7 A.M., at Station 3 in the early morning and again from 8 to 9 A.M. At Station 4 there was little difference except that from 7 to 8 A.M., a lesser percent of samples showed that degree of coliform density. Pollution at Station 5 was greater in the early morning and after 8 A.M. Station 6 became worse after 8 A.M. At Station 7 after 9 A.M. 75% of the samples equalled or exceeded 36/100 ml. and at Station 8, 82% of samples taken between 8 and 9 A.M. were likewise.

The mean MPN/100 ml. for all stations increased with the lapse of time. It was 28, 43, 54, and 115 for the four periods. The mean exceeded 70/100 ml. at Stations 1, 2, and 5 after 9 A.M., at Station 6 after 7 A.M. and at Station 8 between 8 and 9 A.M.

Station 6 is the only station that gave positive samples (12 taken on 7 different days) on all runs made after 9 A.M. The maximum MPN/100 ml. occurred at this station after 9 A.M. during a mid-flood tide. Five boats were clustered about the station and a woman was rinsing laundry on one of the boats. Station 6 is roughly the central station in the anchorage area. It appears that concentration of boats and boat activity do have some measurable effect on the coliform density in the water.

Tidal Movement

A division of samples according to tidal cycle has been made in order to examine the relationship that might exist. The division of tidal quarters was as follows: High Ebbing, Low Ebbing, Low Flooding and High Flooding. The relationships comparable to those for boat activity are expressed in Table 3. 61.5% of all samples taken on low ebbing tide are equal to or greater than 36 MPN/100 ml. According to that standard, high flooding was next with 50%, high ebbing with 46.2% and low flooding with 43.3% to follow.

At individual stations the greatest percentage of samples equal to or greater than 36/100 ml. is in the following order: 1, 2, 3, 4, Low Ebbing; 5, 6, 7, High Flooding; 8, High Ebbing. It is interesting to note that Stations 4 and 8 were affected very little during high flooding tide. Maximum tidal quarter MPN's were recorded for Stations 1, 2, 5, 6, during low ebbing tide, for Station 6 during high ebbing tide, for Station 8 during low flooding tide, and for Station 6 during high flooding tide.

The maximum MPN/100 ml. exceeded 70 at Station 1, 2, 5, 6, and 7 during all quarters. Means equal to or exceeding that limit were found at Stations 1, 2, 5, 6, and 8 during low ebbing tide. The mean at Station 6 was also in excess for the first and fourth quarters of tidal flow. The mean for all stations during low ebbing flow was 101 MPN/100 ml. and for high flooding flow 67. The overall most favorable condition of water was evident during low flooding flow when the mean was 27 MPN/100 ml. and even Station 6 had a mean of only 42.

TABLE 3

CABIN CRUISER POLLUTION SURVEY
Eatons Neck Harbor
1953

Comparison of Pollution Intensity

For Tidal Cycles

Percent of Samples Equal to or Greater than MPN 36/100 ml.

Tidal Quarter	Station 1	2	3	4	5	6	7	8	Total
High Ebbing	46	23	46	23	62	62	38	62	46.2
Low Ebbing	67	67	50	58	75	67	50	58	61.5
Low Flooding	37	62	38	23	31	62	54	39	43.3
High Flooding	50	50	40	10	90	70	70	20	50.0

Percent of Samples Equal to the Maximum MPN

High Ebbing	0	0	0	0	0	8	0	0	1.0
Low Ebbing	8	8	0	0	8	8	0	0	4.2
Low Flooding	0	0	0	0	0	0	0	8	1.0
High Flooding	0	0	0	0	0	10	0	0	1.2

Maximum MPN/100 ml.

High Ebbing	150	91	91	91	91	2100	230	91
Low Ebbing	930	930	91	91	930	930	91	430
Low Flooding	91	73	36	36	91	150	110	230
High Flooding	91	230	36	36	230	2400	91	36

Mean MPN/100 ml.**

	Station 1	2	3	4	5	6	7	8	Total
High Ebbing	36	17	21	12	33	216	35	26	48
Low Ebbing	158	112	27	26	124	255	34	70	101
Low Flooding	20	25	16	13	32	42	32	35	27
High Flooding	35	51	14	4	68	326	31	7	67
Mean of all samples **	61	50	20	14	64	200	35	36	60

** See Note Table 1

TABLE 4

CABIN CRUISER POLLUTION SURVEY
Eatons Neck Harbor
1953

COMPARISON OF COLIFORM DENSITY DURING

STATED CONDITIONS OF TIDAL CYCLE AND SAMPLING PERIOD

		Percent of Samples Equal to or Greater than 70/100 ml.								
		Station								No. Samples
Tidal Quarter	Time Period	1	2	3	4	5	6	7	8	Per Station
1	Before 7:00	25	0	0	75	50	25	0	0	4
High Ebbing	7:00 - 8:00	0	25	25	0	25	75	0	25	4
	8:00 - 9:00	25	25	0	0	0	25	25	0	4
	After 9:00	100	0	0	0	0	100	100	0	1
2	Before 7:00	50	0	50	0	50	0	0	0	2
Low Ebbing	7:00 - 8:00	100	0	0	0	0	0	0	0	1
	8:00 - 9:00	33	33	0	0	67	67	33	67	3
	After 9:00	50	50	17	17	33	100	33	0	6
3	Before 7:00	20	20	0	0	60	20	20	20	5
Low Flooding	7:00 - 8:00	0	0	0	0	0	17	0	17	6
	8:00 - 9:00	0	0	0	0	100	100	100	0	1
	After 9:00	0	0	0	0	0	100	100	0	1
4	Before 7:00	0	0	0	0	0	0	0	0	2
High Flooding	7:00 - 8:00	100	100	0	0	0	0	0	0	1
	8:00 - 9:00	67	33	0	0	67	33	33	0	3
	After 9:00	0	0	0	0	50	75	0	0	4

From the above, one would anticipate that the poorest conditions of water in the Harbor would be found generally during a period of low ebbing tide.

The Combined Effect of Tidal Condition and Boat Activity

The number of samples per station is insufficient to permit valid conclusions regarding the predominant influence on coliform density. When the season's sampling is divided into tidal quarter and time period, every quarter and every period of time has at least one sample per station and some have six per station.

It will be observed from Table 4 that there are some indications of the effect of boat activity. Using Station 6 as an example, regardless of tidal condition the MPN/100 ml. of 70 appears to be exceeded in a greater percentage of samples taken as the activity aboard boats increases. When low ebbing tide and the time period coincided after 9 A.M., this station was above the MPN of 70/100 ml. in all samples. However, the maximum MPN recorded for this station during the season occurred after 9 A.M. during a mid-flood tide condition (High + 9 hours).

Using Stations 3 and 4 located somewhat outside the area of boat anchorage it will be observed that during inflowing tide from low to high there were no samples in excess of 70 MPN/100 ml. On the ebbing tide there were some samples equalling or exceeding that figure before 8 A.M. and after 9 A.M. During the period from 8 to 9 there were no samples exceeding under any tidal condition. There is possibly an indication here that tidal conditions are a greater influence on the general body of water, whereas boat activity influence is more on the immediate waters at the area of boat concentration.

Examination of conditions at each station at the time of occurrence of the maximum observed coliform density gives some further indication of the possible effect of tide and boat activity on the water. Maximum station pollution coincided with low ebbing tidal conditions eight times and with period after 9 A.M. six times. Both conditions occurred coincidently six times. At only one station was the maximum observed on other than an ebbing tide. At only two of the stations did a maximum occur at a time other than after 9 A.M.

Effect of Total Number of Boats

The actual number of boats as such seems to be of little significance other than the fact that when there are more boats there is a chance of more activity. There were from 22 to 58 boats noted at time of survey. It will be noted from Table 5 that maximum MPN's were found at five of the eight stations when the boat count was 36, at two when the count was 43, and at each of five stations when the boat count was 22, 30, 49, and 58.

The total number of boats at anchorage apparently has no observable relation to pollution at a particular station. Station 6 was examined specifically since it represented the most heavily contaminated area of water in the harbor. MPN's of 36/100 ml. or less were recorded for boat counts of 22, 30, 36, 43, 49, 50, 55, and 58. Seven negative samples were obtained when boat counts were 30 or less, but eight negative samples were found when boat counts were 50 or more. A maximum MPN/100 ml. of 2400 was recorded with a boat count of 30 while a maximum of 230 was found with a boat count of 58, and a maximum of 2100 occurred when the boat count was 49.

Effect of Seasonal Build-up.

It is not apparent from the data that any marked cumulative residual effects occur. Heavy pollution at specific stations occurred in August, July and May.

TABLE 5

CABIN CRUISER POLLUTION SURVEY
Eatons Neck Harbor
1953

STATION CONDITIONS AT TIME OF OCCURRENCE
OF
MAXIMUM MPN

Station	MPN/100ml.	Date	Time A.M.	Condition at Station: Quarter Tidal	Weather	Wind MPH	Boat Count No.	Remarks
1	930	16 Aug.	09:22	2	Clear	0	36	
2	930	16 Aug.	10:32	2	Clear	1-3	36	Clamming Party
3	91	30 May	07:00	2	Clear	5-10	22	
	91	2 Aug.	07:24	1	Overcast	0	43	4 boats near station
	91	16 Aug.	09:27	2	Clear	0	36	
4	91	16 Aug.	09:32	2	Clear	0	36	
	91	30 Aug.	06:52	1	Clear	1-3	58	Natural Scum
5	930	16 Aug.	10:19	2	Clear	0	36	Swimming & Fishing near station
6	2400	26 July	09:31	3	Clear	3-5	30	5 Boats near station, woman rinsing laundry
7	230	4 July	09:30	2	Clear	5-7	49	4 Boats near station
8	430	2 Aug.	09:07	2	Overcast	5-7	43	

TABLE 6

CABIN CRUISER POLLUTION SURVEY
Eatons Neck Harbor
1953

Comparison of Two Stations
to show
Observed Effect Due to Month of Sampling

Station	Period under Study	No. Samples	Percent Distribution of MPN			
			30*	36-70	71-230	230+
4	4 Surveys 6/28-7/26	20	85	15	0	0
	5 Surveys 8/2-8/30	25	60	32	8	0
	% Decrease or Increase		-15	+7	+8	0
6	4 Surveys 6/28-7/26	20	45	15	25	15
	5 Surveys 8/2-8/30	25	32	16	16	36
	% Decrease or Increase		-13	+1	-9	+11

Note - Period 1 : 6/28-7/26 Includes two Ebbing Tides and two Flowing Tides.

Period 2 : 8/2-8/30 Includes three Ebbing Tides and two Flowing Tides.

The total period covers 9 consecutive surveys.

* Less than or equal to value shown.

On 16 August, five of the eight stations had the maximum coliform density recorded at the station. These stations were 1, 2, 3, 4, and 5. Only two maximums were exceeded in July, those for Stations 6 and 7. One maximum was recorded for Station 3 on 30 May. Station 4 is representative of least pollution and Station 6 of most pollution. A seasonal comparison of these two stations is shown in Table 6. Nine consecutive periods of sampling were divided into those occurring in June and July and those occurring in August. The second period shows some increase in pollution density, but there appear to be possible reasons for that increase other than that of the date of sampling. The percentage of negative samples is less in August than in July by about the same percentage at both stations (15 and 13% for Stations 4 and 6 respectively). Since a shift of value in one sample could change the observed effect by 8 to 10%, these data do not appear to show even a trend.

Direct Effect of Boat Waste Discharges

During the several surveys, toilet paper, feces, bits of food and food preparation wrappings and other debris traceable to boat activity were observed. To be sure these items were not always seen but the presence of floating feces at any time in water used for swimming and covering the areas from which clams were taken at every low tide during the period of survey is not a condition to inspire confidence in the continuing safety of such water. Debris of boat origin was spotted 75 times during the period and on 23 occasions fecal matter, vaginal protective material or toilet paper were spotted in the debris.

The New York State Water Pollution Control Board standards for tidal salt waters used for bathing specify that there should be no floating solids, settleable solids, or sewage or waste effluent not effectively disinfected. The Public Health Service recommended provision for approved shellfish areas states, "The sanitary survey shall disclose no likelihood that human fecal discharges reach the area in dangerous concentrations or before sufficient time has elapsed to render such discharges innocuous". The record at Eatons Neck shows the following observed conditions by station.

	No. of Times Solids Observed	
Station	Debris of Any Kind of Boat Origin	Feces, Toilet Paper or Vaginal Protection
1	9	4
2	7	4
3	11	2
4	6	2
5	8	2
6	15	5
7	15	4
8	4	0
Total	75	23

It seems extraneous to point out that the observed materials were all relatively fresh and easily recognizable. They represent a positive potential hazard to health that is of greater significance than coliform density measurements. There could be no question of their source. Their presence is directly related to boat activity. Their dispersion and eventual disappearance from the harbor are a function of tidal currents and volume displacement.

That some concentration of pollution eventually finds its way to the outer

channel is shown by the observance of floating matter near Station 8 and in the channel itself. That the dispersed material still may remain in the outgoing waters is shown by the occasional positive results observed in Station 8 samples. (Maximum MPN 430/100 ml. after 9 A.M. on an ebbing tide, seasonal mean MPN 36/100 ml.)

On the week-end of 9 August there was an opportunity to observe any effect of storm on the water. The effect was negligible. Although the water was dirty in appearance and contained much natural floating solids of marine origin, there was no increase in coliform density. It is probable that there may have been some benefit. On that day Stations 4 and 8 had no positive samples. Stations 1, 2, 3, and 7 had no concentration above 36/100 ml. MPN. Coliform densities above 70/100 ml. occurred at Station 5 and 6 after 9 A.M. on a flooding tide.

Interpretation of Results

Transfer of these survey data into generalized observations applicable to all harbors is manifestly impossible. The control data on the harbor are too meager to permit a conclusive statement as to whether the harbor is more polluted because of the presence of small craft than it was before. Stations 3 and 4 were sampled throughout the survey and seem to be comparatively free of pollution. The mean MPN's at these stations are of the same magnitude as those obtained by the New York State Conservation Department. The following shows the relation between week-end surveys and "off-season" surveys for both maximum and mean results.

	Max. MPN/100 ml.		Mean MPN/100 ml.	
Station	Off-season	Weekends	Off-season	Weekends
3	23	91	23	20
4	23	91	10	14
1	240	930	114	61
2	43	930	28	50
5	23	930	23	64
6	1100	2400	375	200
7	23	230	18	35
8	23	430	23	36

During the period of survey 53% of the samples equalled or exceeded 30/100 ml. At Station 3 the comparable frequency was 48%; at Station 4, 33%; at Station 5, 71%; at Station 6, 62%; at Station 7, 58%; at Station 8, 48%; and at Stations 1 and 2, 52%.

There is reasonable evidence to show that boats at anchorage and in use in small harbors do have some effect on the harbor water at Eatons Neck. The effect appears to be closely related to levels of boat activity, and particular types of activity; to boat concentration about a particular sampling point; and to the direction of tidal flow. The trend of excessive coliform density is toward higher values following boat activity and on ebbing tide below mid-tide. Periods after 8 A.M. during ebbing tides show consistently high levels of pollution. All but Station 8 show some percentage of samples in excess of New York State Water Pollution Control Standards when sampled after 9 A.M. on a low ebbing tide.

Certain stations associated with boat congestion show higher levels of pollution than do others outside of anchorage area. The inference is that specific boat activity at or near a sampling station affects the coliform density of water in the station area.

Normal changes in weather condition do not appear to have any measurable effect on water pollution, since boat activity continues while the boat is at the anchorage. A severe storm could not be shown to have had any outstanding effect. Possible flushing action in the basin might be inferred but this effect could not be singled out from other variables known to have influence.

There was no apparent building up of residual pollution in the basin. Minor increases have been demonstrated but these, too, may have been the result of other influencing factors.

Probably one of the most significant measures of the effect of cabin cruiser waste discharge on the basin is the repeated observance of refuse and wastes from boats in the harbor. Of 75 times boat originated debris was spotted, fecal matter, vaginal protective material or toilet paper was found on 23 occasions. If any conclusion may be drawn, it is that because of the presence of fresh fecal discharges emanating from boats, immediate waters are unsafe for bathing. For the same reason it may be concluded that the waters are not approvable as shellfish areas. In addition 20% of all samples taken during the season showed an MPN in excess of that recommended for approved shellfish waters. Even in the cleanest water station area sampled, that standard was exceeded in 4% of the stations sampled.

Official Agency Control

A direct canvass of pollution control agencies was made to determine what measures if any were being taken to control the discharge of wastes from small craft into harbor waters.

Twenty-six State Health Departments, eight Municipal Health Departments, seven Water Pollution Control Units, four University Professors, the Tennessee Valley Authority, the United States Public Health Service Environmental Health Center, and the Division of Medical Sciences of the National Research Council were canvassed on the issue. Replies were received from twenty-three of the State Health Departments and from twenty-one of the balance. Additional letters were also sent concerning the present study. In all, twelve correspondents reported positive information.

California - Nevada

In California, a study of San Diego Bay is in progress. The Water Pollution Control Board, Region 6, contemplates action to prohibit the discharge of wastes any place on Lake Tahoe since shore resorts and cabins have water intakes immediately off-shore. The Nevada State Health Department has forced one large recreational boat to install water tight storage tanks for all wastes. The tanks are emptied to shore installations under Health Department supervision. Los Angeles City Health Department makes harbor inspection of eleven yachts and small boat anchorages. Each anchorage operator is responsible for enforcement of the law which prohibits depositing of anything in harbor waters such as cans, rags, paper, garbage or other debris including offal, feces or anything which might pollute the waters. Toilet facilities are available on shore at each anchorage. Garbage cans and trash cans are provided by the management and all waste is disposed of on shore. Rules are set up and strict compliance is required of all boats. Permanent tenancy is discouraged and not permitted in the majority of anchorages. As a result of strict enforcement of regulations by the operators there is no problem from pollution by them. Very little if any discarded material is in evidence according to the inspection reports.

District of Columbia

The District of Columbia Health Department has made no quantitative surveys, but has made observations of the floating evidence of boat pollution and has prepared regulations, not yet adopted, that would require the deposition of boat wastes on shore in suitable places.

Maine

The State of Maine has made numerous investigations of the pollution of harbor waters,[4] but none of the work has been directed to the specific effect of cabin cruiser pollution. Standards used for closing an area of salt water are based on MPN of coliforms. For clam digging, water exceeding 70/100 ml. is considered unsafe. For bathing water in which any single sample exceeds 1000/100 ml. the water is immediately subject to re-sampling and the area is closed wherever any single sample shows 3000 or more.

Maryland

The Maryland State Health Department Division of Sanitary Engineering, in 1949, studied the effects of pollution from discharges of pleasure boats in Chesapeake Bay and its tributaries. A circular letter was sent to all State Sanitary Engineers by George L. Hall, Chief Sanitary Engineer. At that time, 20 states considered that sewage discharge from small boats constituted no pollution problem. States that had considered the problem offered 4 recommended measures for control.

1. The use of chemical toilets with disposal of contents in properly maintained pits at least 50-feet from the waterline on shore.
2. Suitable water-tight tanks on boats for receiving solid and liquid waste materials for disposal at other points.
3. Sanitary equipment on boats must be approved at time of boat registration and meet proper specifications.
4. Restriction of use of areas (shellfish) by operators of boats.

Maryland has enlisted the voluntary cooperation of all yacht clubs by discussion of the problem with club members, and by a one-page circular sent with the endorsement of each yacht club's Board of Governors appealing to individual members.

Michigan

The City of Detroit has a number of ordinances mentioning the deposition of material in the Detroit River. Some tentative standards of the Metropolitan Regional Planning Commission establish water quality criteria for natural recreational bathing and recreational boating. The Detroit Yacht Club has regulations requiring members residing on boats to use sanitary facilities provided on shore. No serious pollution tracable to small craft anchorage has been observed at the public bathing beach down stream.

North Carolina

The State Stream Sanitation Committee of North Carolina is presently engaged in a survey of waters around Morehead City. The survey will include the pollution from pleasure craft plying the inland waterway as well as that from other sources.

4. Report on Water Pollution in the State of Maine, 1950 Maine Department of Health & Welfare, Division of Sanitary Engineering

New Jersey

New Jersey Health Department has some regulatory control of the pleasure craft, however, the control effort at present is confined to the posting of signs inside cabin cruisers. These signs call attention to the need for cooperation in protecting beaches and shellfish.

New York

A local ordinance in Mamaroneck Harbor, Westchester County, prohibits the use of toilet facilities on any boat and prohibits the discharge of refuse or offensive wastes to the harbor waters. Nassau County, Long Island, has had the benefit of some local press editorials calling attention to pollution by small boats and the need for keeping Long Island waters clean.

Oregon

Pollution of harbors with house-boat discharge is a recognized problem, but the differentiation of that pollution effect from that of other sources has not been possible.

South Carolina

Seasonal traffic of pleasure craft on the inter-coastal waterways creates a potential hazard, however, no specific attempt has been made to evaluate that hazard. Waterways, surveyed in connection with shellfish control have shown that heavy fall and spring traffic may pollute areas that ordinarily are relatively free of contamination.

United States Public Health Service - Lake Michigan Survey

In 1948, as part of a Tri-State Survey,[5] a study was made at the entrance of each of the small boat harbors along the Chicago Lake front. Small boat harbor entrances, along the Chicago Lake front, were sampled. In no location were MPN's/100 in excess of 240 found in more than 30% of the samples. Boats were not occupied over night. Toilet facilities are provided at yacht clubs and park district comfort stations.

Consideration of Hazards

Cabin cruisers may provide sleeping accomodations for from one to five persons and occasionally extra persons may occupy the craft for short periods of time. A conservative estimate of the normal boat population may be taken as three when in recreational use. Discharges are fresh and pathogenic organisms present in those discharges are viable. The only protection afforded is that offered by dispersion and dilution in the receiving waters.

Bathing

From a public health viewpoint, bathers entering water containing freshly discharged pathogens may be exposed to any of the intestinal diseases normally transmitted directly by fecal discharge. In salt waters, the accidental swallowing of large quantities is exceptional, but approximately 50 ml. may be taken

5. Tri-State Survey of Lake Michigan Waters, Preliminary Report, Pub. Health Service, Environmental Health Center, 1948.

into the mouth and expelled again as a normal practice. Some small portion remains within the body and, during the course of a swim, several such portions may enter the alimentary canal and the intestinal tract. Drinking water standards presume that waters with a coliform MPN of more than 5/100 ml. are unsafe for drinking. If, during the course of a day, a person drinks 1 liter of water, he would have imbibed 50 coliforms. Hence, it may be advanced that in the ingestion of freshly contaminated water while bathing a probable concentration of 50 coliforms would represent a hazard of equal proportion. A probable concentration of 50 in a mouthful of water would be 1 per ml. It is then reasonable to assume that bathing waters having an MPN/100 ml. of 100 or more are to be viewed with suspicion. Some standards consider that MPN's of more than 50/100 ml. indicate doubtful bathing water quality.

Shellfish Culture

Pollution standards for water over shellfish beds include those established by the Public Health Service, by the New York State Department of Conservation and by the New York State Water Pollution Control Board. Such standards apply to the waters of Eatons Neck Harbor. The United States Public Health Service Standards provide for a sanitary survey and compliance with a coliform standard. If the survey determines that the shellfish area is subject to gross pollution by direct discharge, or is exposed to occasional direct and immediate contamination with human fecal discharges the area is considered polluted. The coliform standard of 70/100 ml. MPN has been used as the border line between approvable water and polluted water.

For waters having a best usage of shellfish culture the New York State Water Pollution Control Board follows the PHS standard of 70/100 ml. MPN. For bathing the requirements for Class SB waters do not allow floating solids attributable to sewage or other wastes, garbage or other refuse, non-disinfected sewage waste effluents, or substances or wastes in sufficient amounts to make the water unsafe for bathing.

Aesthetics

Water used for recreational purposes should be reasonably free of floating solids such as garbage. Any visible evidence of fecal discharge or of vaginal protection is obnoxious and suggestive of foul water. One does not react favorably to bathing in such water or even to using it for cleaning purposes.

Oil and grease laden waters are of course objectionable for swimming or cleaning and mar the paint of recreational craft.

SUMMARY

It appears from the studies made that:

1. The water at any sampling station was on at least one occasion polluted according to shellfish standards although, in the majority of samples, the bacteriological quality of the water was under the limit of 70/100 ml. MPN.
2. Direct contamination with human discharges is a common occurrence where activities aboard the craft are those that may be normally expected among a recreational boat population.
3. Bathing in waters adjacent craft in a sheltered harbor is aesthetically undesirable, and may be hazardous to individuals mouthing and swallowing small quantities of water.

4. Objectionable conditions occur with sufficient frequency to justify careful surveillance of sheltered harbor areas used for both anchorage and recreational pursuits.
5. Sheltered harbor supervision should take into account activity aboard boats, tidal movement, if any, and the relative position of craft with respect to bathing area and shellfish beds.
6. Measures to improve the handling and treatment of craft wastes before discharge appear desirable and may be necessary in harbors having pollution effects more severe than those shown in the present study.